A Film-less, No-Waste Solution for Flash X-Radiography at Los Alamos National Laboratory's DX-3

Abstract:

The Dynamic Experimentation Division Hydrodynamics Applications Group (DX-3) at Los Alamos National Laboratory has redesigned their flash radiographic imaging system to eliminate waste and improve mission performance. For DX-3, photochemicals and x-ray film are big waste streams. For photography, going digital is the best solution, but for flash x-radiography, digital does not always work. For explosive testing of nuclear weapons mock-ups, DX-3 has implemented phosphor-imaging technology in place of x-ray film. As a result, DX-3 saved $105,000 dollars per year; eliminated 450 gallons of chemicals waste, decommissioned a large costly darkroom, and avoided large amounts of unused film disposal.

Nomination Description:

The DOE stockpile stewardship program conducts explosive tests of nuclear weapons mock-ups using surrogate "non-nuclear" materials. In these "hydrotests" subsystem performance is measured by taking flash X-ray pictures of the test (Figure 1). This process is similar to a medical x-ray in the doctor's office except instead of x-raying humans, DX-3 x-rays an explosion.

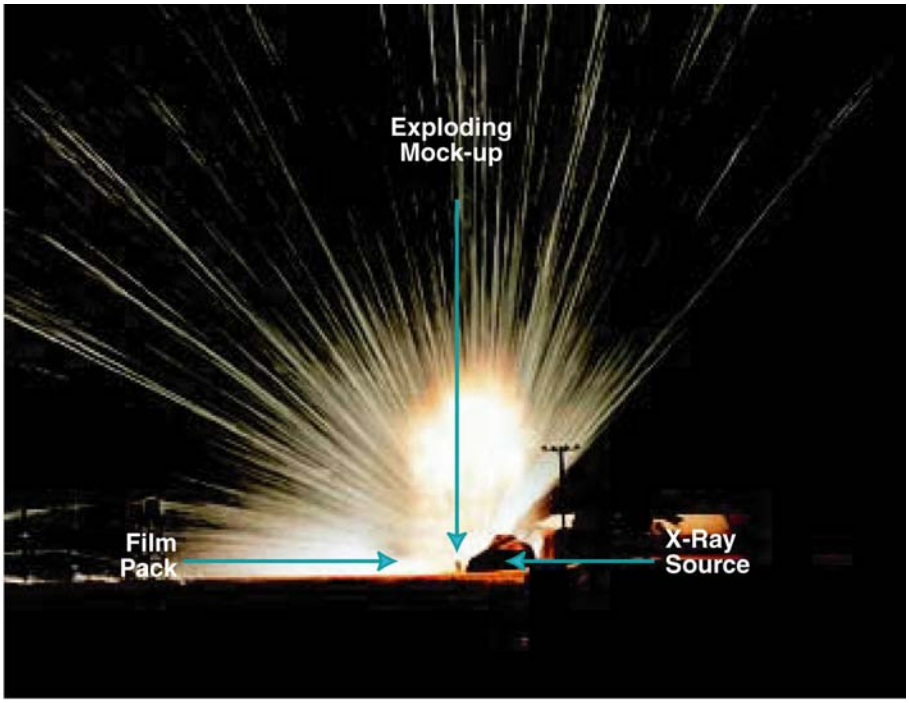

Figure 1 illustrates the process of taking flash x-ray pictures of high explosives. This process is similar to a medical x-ray except instead of x-raying humans, DX-3 x-rays an explosion.

Prior to this innovative improvement of using a phosphor-imaging scanner (screen and scanner), DX-3 recorded film images of the explosion and developed the film chemically in a special darkroom facility. Then, special digitizers were used to convert the film to an electronic record. Occasionally, all data from an explosive test was lost when shrapnel penetrates the film assembly letting in light. In addition, DX-3 could only purchase a production run of film while the hydrotests only required a small amount. As a

result, 90% of the film was disposed unused because it could not be used before exceeding the film's lifetime. The significant costs of film radiography are captured in Table 1.

Table 1 Yearly Costs for Radiographic Film Processing	
Chemical Waste Management	$12,000
Chemical Waste Disposal	$12,000
Facility Costs for Film Processing	$12,000
Unused Film	$12,000
Film Developing Labor	$76,000
Digitizing Labor	$76,000
Total	**$200,000**

Table 2 Phosphor Scanning Process	
Labor Costs	$95,000
Savings (Yearly cost)	**$105,000**

As a part of continuing commitment to pollution prevention, DX-3 has tested many possible solutions searching for a more effective, zero waste alternative to the x-ray film approach. They determined that the phosphor scanner and screen was the best option (many are already used in hospitals for x-raying humans). However, the size of the scanner and screen normally used in medical radiography was too small. DX-3 worked with manufactures to develop a scanner and screen large enough for hydrotesting x-radiography. The before and after costs of the x-ray film process and phosphor-imaging technology are compared in Tables 1 and 2; $105,000 will be saved annually. The ROI is 125% and is based on the costs of the film x-raying process, annual cost saving with the phosphor imaging system, useful project life (10 years), and implementation cost ($120,020 for one scanner and six screens).

The benefits of this innovated imaging system are numerous. At least 20 hours of labor per experiment are saved because film no longer has to be developed or digitized. Each sheet of film required over an hour to be developed, so processing the film from one experiment required at least one day. In contrast, a phosphor screen can be interpreted by a special laser reader within a few minutes, and does not require film development. In addition, in the past, x-ray data was collected with multiple sheets of radiographic film, but now the same data can be captured on a single phosphor screen. Also, a traditional film pack weighs about 150 pounds when all of the sheets of film are combined with the appropriate shielding, but the phosphor screen pack only weighs about one tenth as much, making the set-up physically easier and safer. As stated earlier, film was sometimes ruined when shrapnel penetrate the film. Phosphor screens are not as sensitive to visible light as film, so screens are not damaged as easily. If there is a breach in phosphor screens, data is not lost. Phosphor screens can also be cleaned and reused repeatedly. Finally, the screens' lower light sensitivity means they can be handled/read out in a low light room, whereas film requires total darkness.

By switching to the phosphor screens, DX-3 saves $105,000 annually from eliminated chemical and film waste, darkroom space costs, and significant labor savings. This innovative improvement is a significant success story for the DX-3 group because a simple process redesign reaped so many benefits.

The team of individuals nominated to receive DOE P2 Awards for their work on this project include: Aaron J Honey, Dynamic Experimentation Division Hydrodynamics Applications Group (DX-3), Gregory S. Cunningham, Dynamic Experimentation Division Hydrodynamics Applications Group (DX-3), Joseph M. Gonzales, Dynamic Experimentation Division (DX-DO), Gary M. Childers, Business Operations Division Defense Group (BUS-2), Karen L. Warthen, Dynamic Experimentation Division Detonation Science and Technology Group (DX-1), Todd J. Kauppila, Dynamic Experimentation Division Hydrodynamics Applications Group (DX-3), Monica L Andersen, Dynamic Experimentation Division Hydrodynamics Applications Group (DX-3). For more information, contact Karl Mueller at Karl.Mueller@spole.gov or Greg Cunningham at cunning@lanl.gov. For more information about the Laboratory's Environmental Stewardship Program, contact Tom Starke at tps@lanl.gov.